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PATENT

THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Yasuhiro KOIZUMI et al

Art Unit:

S. N. 09/920,450

Examiner:

Filed: August 1, 2001

For: DEFECT INSPECTION APPARATUS  
FOR PHASE SHIFT MASK

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Please make the following amendments to this application  
prior to examination thereof:

In the Specification:

**Page 2, lines 8-15, delete this paragraph and substitute the  
following:**

Phase shifter defects on such phase shift photomasks may be generated in the mask making process. Examples of phase shifter defects are a partially unfinished phase shifter due to adhesion of a contamination to a region where a 180° phase shifter is to be formed, and an excess or overetched phase shifter due to a resist pinhole or the like present in a region where no phase shifter should be formed.

**Page 5, lines 13-20, delete this paragraph and substitute  
the following:**

To attain the above-described object, the present invention provides a defect inspection apparatus for a phase shift mask

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having a phase shifter pattern provided on a mask transparent substrate. In the defect inspection apparatus, after the phase shifter pattern has been formed, a phase shifter defect inspection is performed from the mask transparent substrate side of the phase shift mask.

In the Claims:

**Please amend claim 1 by replacing it with the like numbered claim hereinbelow.**

1. (Amended) A defect inspection apparatus for a phase shift mask having a phase shifter pattern provided on a mask transparent substrate, which is characterized in that after said phase shifter pattern has been formed, a phase shifter defect inspection is performed from a mask transparent substrate side of said phase shift mask.

In the Abstract:

**Please amend the abstract by deleting it and replacing it with the new abstract as follows:**

The present invention relates to a defect inspection apparatus for a phase shift mask that is capable of detecting phase shifter defects that cannot be detected by conventional inspection techniques, by a simple method using an optical method and a comparison of electric signals. In a defect inspection apparatus for a phase shift mask having a phase shifter pattern provided on a mask transparent substrate 1, after the phase shifter pattern has been formed, a phase shifter defect

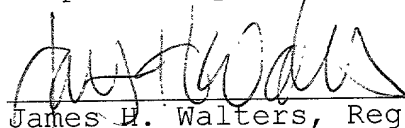
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inspection is performed from the mask transparent substrate 1 side of the phase shift mask 1. To perform the defect inspection, light 12 is applied to the phase shift mask 1 from the mask transparent substrate 1 side thereof, and reflection images of at least two different phase shifter pattern fabricated regions are captured by photoelectric conversion light-receiving elements 15a and 15b. The respective image signals 17 and 18 of the reflection images are compared with each other to detect a defect on the mask from the difference between the signals.

REMARKS

The above amendments are presented for clarification of the invention. Markup sheets are provided at the end of this document to illustrate the changes made for the Examiner.

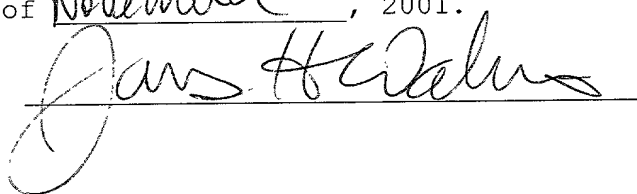
Respectfully submitted,

  
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**MARKUP SHEET SHOWING CLAIM AMENDMENTS MADE HEREIN**

1. (Amended) A defect inspection apparatus for a phase shift mask having a phase shifter pattern provided on a mask transparent substrate [to produce a phase difference in transmitted light], which is characterized in that after said phase shifter pattern has been formed, a phase shifter defect inspection is performed from a mask transparent substrate side of said phase shift mask.

light-shielding pattern 32 of chromium is provided in the form of a repeated pattern, and the transparent substrate 31 is etched at alternate space regions between the adjacent portions of the light-shielding pattern 32 to a depth corresponding to a half of the working wavelength (about 180° in terms of phase difference) to form trenches 33.

Phase shifter defects on such phase shift photomasks may be generated in the mask making process. Examples of phase shifter defects are a partially unfinished phase shifter due to adhesion of a <sup>Contamination</sup> ~~foreign matter~~ to a region where a 180° phase shifter is to be formed, and an excess or overetched phase shifter due to a resist pinhole or the like present in a region where no phase shifter should be formed.

The edges of phase shifter forming regions are formed under the chromium pattern, and the phase shifter is formed at a light-transmitting portion. For these reasons, all the above-described phase shifter defects cannot be detected by a conventional inspection method using transmitted light or a conventional inspection method in which both the front and back surfaces of a phase shift photomask are illuminated with light and the reflected light and the transmitted light are compared with each other. Therefore, the following inspection method is presently employed. The pattern of a photomask under inspection is transferred onto a wafer by an exposure system, and whether or not there is a defect is

phase shift mask for such small defects. Accordingly,  
there will be no means for evaluating phase shift masks.

#### SUMMARY OF THE INVENTION

5           The present invention was made in view of the above-described circumstances of the prior art. An object of the present invention is to provide a defect inspection apparatus for a phase shift mask that is capable of detecting phase shifter defects that cannot be detected by  
10 the conventional inspection techniques, by a simple method using an optical method and a comparison of electric signals.

          To attain the above-described object, the present invention provides a defect inspection apparatus for a  
15 phase shift mask having a phase shifter pattern provided on a mask transparent substrate ~~to produce a phase difference in transmitted light~~. In the defect inspection apparatus, after the phase shifter pattern has been formed, a phase shifter defect inspection is performed from the  
20 mask transparent substrate side of the phase shift mask.

          In this case, it is desirable to perform the defect inspection in such a manner that light is applied to the phase shift mask from the mask transparent substrate side thereof, and reflection images of at least two different  
25 phase shifter pattern fabricated regions are captured. Then, the respective image signals of the reflection images are compared with each other to detect a defect on the mask from the difference between the signals.

# ABSTRACT

The present invention relates to a defect inspection apparatus for a phase shift mask that is capable of detecting phase shifter defects that cannot be detected by conventional inspection techniques, by a simple method using an optical method and a comparison of electric signals. In a defect inspection apparatus for a phase shift mask having a phase shifter pattern provided on a mask transparent substrate 1 ~~to produce a phase difference in transmitted light~~, after the phase shifter pattern has been formed, a phase shifter defect inspection is performed from the mask transparent substrate 1 side of the phase shift mask 1. To perform the defect inspection, light 12 is applied to the phase shift mask 1 from the mask transparent substrate 1 side thereof, and reflection images of at least two different phase shifter pattern fabricated regions are captured by photoelectric conversion light-receiving elements 15a and 15b. The respective image signals 17 and 18 of the reflection images are compared with each other to detect a defect on the mask from the difference between the signals.